IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Bing Chiang, James A. Proctor, Jr. and Kenneth M. Gainey

Continuation Application of

Application No.: 09/774,534

Filed: January 31, 2001

For: ELECTRONIC PHASE SHIFTER WITH ENHANCED PHASE SHIFT PERFORMANCE

Date: 10/22/03

EXPRESS MAIL LABEL NO. EV 052031388 US

REMARKS

Mail Stop PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The above-captioned application is a continuation of application number 09/774,534 filed on January 31, 2001 to which priority is claimed under 35 U.S.C. §120.

The specification of the present application is substantially the same as that of the parent application. A related applications paragraph has been added as the first paragraph in the specification.

All of the claims from the parent application have been omitted. A new claim set is being presented herein for examination.

Claims 1-35 are pending the application. In a Final Office Action mailed from the United States Patent and Trademark Office on April 22, 2003, Claims 1 and 19 (formerly 16) were rejected as being unpatentable over Arevalo (US Patent No. 6,104,986). Applicants respond accordingly.

The present invention achieves a wider phase shift range by modifying the standard instrumentation line impedance of a standard or typical directional coupler. A typical four-port directional coupler includes an input port, an output port, a first quadrature port, and a second quadrature port. The typical directional coupler has a characteristic input/output port impedance and a characteristic quadrature port impedance. The characteristic input/output port impedance and the characteristic quadrature port impedance are typically "matched" to provide for best performance. For example, engineers are trained to use "a standard 50 ohm to 50 ohm design" when designing microwave circuits. (See Specification, page 3, lines 18-20, and page 9, lines 9-11.).

The present invention modifies this "standard 50 ohm to 50 ohm design" such that the characteristic input/output impedance is different from the characteristic quadrature port impedance. The modification is accomplished by embedding two quarter-wave transformers (circuit traces) into the directional coupler. A first circuit trace runs from the input port to the first quadrature port and a second circuit trace runs from the second quadrature port to the output port. The impedance of each circuit trace is determined from the equation $Z_{OT} = \sqrt{Z_{O1}Z_{O2}} / F_{QC}$, where Z_{O1} is the input/output port impedance, Z_{O2} is the quadrature port impedance, and F_{QC} is a quadrature hybrid coupling factor. A 22 ohm circuit trace impedance is used, for example, to transform the characteristic quadrature port impedance from 50 ohms to 20 ohms. (See Specification, page 2, line 21 through page 3, line 8.).

The transformation provides for an increase in phase shift range to approximately 200° over the "standard 50 ohm to 50 ohm design" of the prior art as illustrated in the Smith Charts of Figs. 4A and 4B. Additionally, a varactor diode is attached to each quadrature ports and are biased by an input control voltage applied to the quadrature ports. The biasing allows the phase shift to vary over a broader range of degrees in both the capacitive and inductive zones about the 180° point, as shown in Fig. 4B.

Arevalo also achieves a wider phase shift range using a typical 3 dB hybrid structure (directional coupler) with microstrip elements in each of its four legs. However, Arevalo adds a voltage controlled phase shifting circuit to the typical directional coupler. A controller drives a digital-to-analog (D/A) converter to control the bias voltage of the phase shifting circuit and thereby adjust the phase shift of a high frequency output signal relative to the high frequency input signal.

We agree that Arevalo suggests that the microstrip elements of the typical directional coupler have widths that correspond to a desired impedance of each leg and that the legs need not have the same widths. However, this suggestion in and of itself does equate to the characteristic quadrature port impedance being different from the characteristic input/output port impedance and most certainly does not equate to adding impedance transformers to transform the characteristic quadrature port impedance to provide a greater phase shift range as is claimed in the present invention.

The Examiner actually concedes that Arevalo does not teach (1) the characteristic input/output port impedance being different from the characteristic quadrature port impedance; (2) the first impedance transformer transforming the characteristic input/output impedance across the input port and output port to the characteristic quadrature port impedance across the quadrature ports; (3) the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output port impedance; (4) the characteristic input/output port impedance is 50 ohms; (5) the characteristic quadrature port impedance is 20 ohms; and (6) the characteristic quadrature port impedance is lower than the characteristic input/output port impedance. The Examiner makes a "general conclusion" that one of ordinary skill in the art would have found these limitations 1-5 obvious. However, the Examiner does not provide specific factual findings along with some concrete evidence in the record to support these findings. Therefore the Examiner's "general conclusion" does not support an obvious rejection. (See MPEP 2144.03).

As stated above, Arevalo adds a phase shifting circuit to a typical directional coupler and does not modify the typical directional coupler as is claimed in the present invention. As such, one skilled in the art would not modify the typical directional coupler to transform the standard characteristic quadrature port impedance to be different from the characteristic input/output port impedance. Most certainly, one skilled in the art would not modify the typical directional coupler such that the characteristic quadrature port impedance is lower than the characteristic input/output port impedance as recited in Claims 17, 18, and 35. Therefore, the Examiners reasoning does not support a case for *prima facie* obviousness for at least these claims.

In view of the above remarks, it is believed that Claims 1-35 are in condition for allowance, and it is respectfully requested that the application be passed to issue. Applicant requests a telephone conference with the Examiner prior to the issuance of an Office Action.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By _____

David J. Thibodeau, Jr.
Registration No. 31,671
Telephone: (978) 341-0036
Facsimile: (978) 341-0136

Concord, MA 01742-9133
Dated: Oct. 22, 2003